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ABSTRACT

Adeptness in abstractions and analysis--the language of math--is at least as important as adeptness at reading words for individuals in business and industry. Mathematics literacy stimulates the problem-solving and critical thinking skills that the workplace now demands. A National Assessment of Educational Progress study found that about half of high school graduates do not have junior-high level math skills. Patterns indicate that males and high-achieving students are the only groups whose use of computers is increasing. Instructional changes to improve math achievement include (1) making computers and calculators available to all students; (2) reflecting real-world math applications in problems and projects; and (3) integrating probability, statistics, and discrete math into the curriculum for all students. Other recommendations are changes in textbook content and student evaluation, business involvement in advocating math programs, and greater equity, that is, higher expectations in math performance for all students. (The document includes three graphs and the names, addresses, and phone numbers of eight sources of information.) (CML)

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MYTH # 8:

READING IS MORE IMPORTANT THAN MATH

Any talk of the literacy problem in the United States almost always centers on literacy with words--on reading.

But discuss literacy with those from business/industry, and you will find a different view. Except for most business office skills, the issue for workplace literacy and, consequently, for a majority of both adults and the future workforce, is adeptness in another language--that of abstractions and analysis, the language of math.

Until the beginning of this decade, adult education/training conducted by the business community primarily focused on self-development of individuals. Because of global competition, this training has become self-survival of the businesses and industries, and the focus has turned on skills needed for technological change. Increasingly, these are analytical and deal with quantities, charts, graphs, percentages and statistics. Math and science performance by workers in general, not just professionals, holds the key to global competition, say economists and other experts.

For example, a PBS documentary earlier this year on workplace literacy, "A Job to Be Done," used exemplary training programs almost entirely oriented toward higher-order math skills. A recent report of industrial adaptation to technology in the South by the Southern Technology Council found that the core of training programs was math and the analytical skills that it encourages. Thierry Noyelle, in a paper for the Institute on Education and the Economy at Teachers College/Columbia University, argues that as intelligent machines take over processing functions once performed by individual workers, the workers must become skillful at diagnosing and at problem solving.

Students need to know more about planning, making sense of statistics and other data and assessing probability because these are the problems most often faced by industry, Henry Pollak, former researcher for Bell Communications Research, Inc., told a conference of math educators earlier this year.

Those who work in the applied sciences and math contend that math literacy stimulates the problem-solving, critical-thinking skills that the workplace now demands. Researchers back this up. John Bishop of Cornell University, in a paper for the current assessment of vocational education, describes research studies showing extremely strong correlations between high-content math courses (algebra II, trigonometry) and such indicators as self-esteem, work orientation and internal locus of control. The studies also show that enrollment in these courses produces substantial improvement in other academic work.

. . . A Clue to Problems

After the eighth grade, the number of students taking math courses decreases by one-half each year all the way through graduate school. Each year the United States graduates only 700 doctoral students in math, and one-half of these are from other countries.

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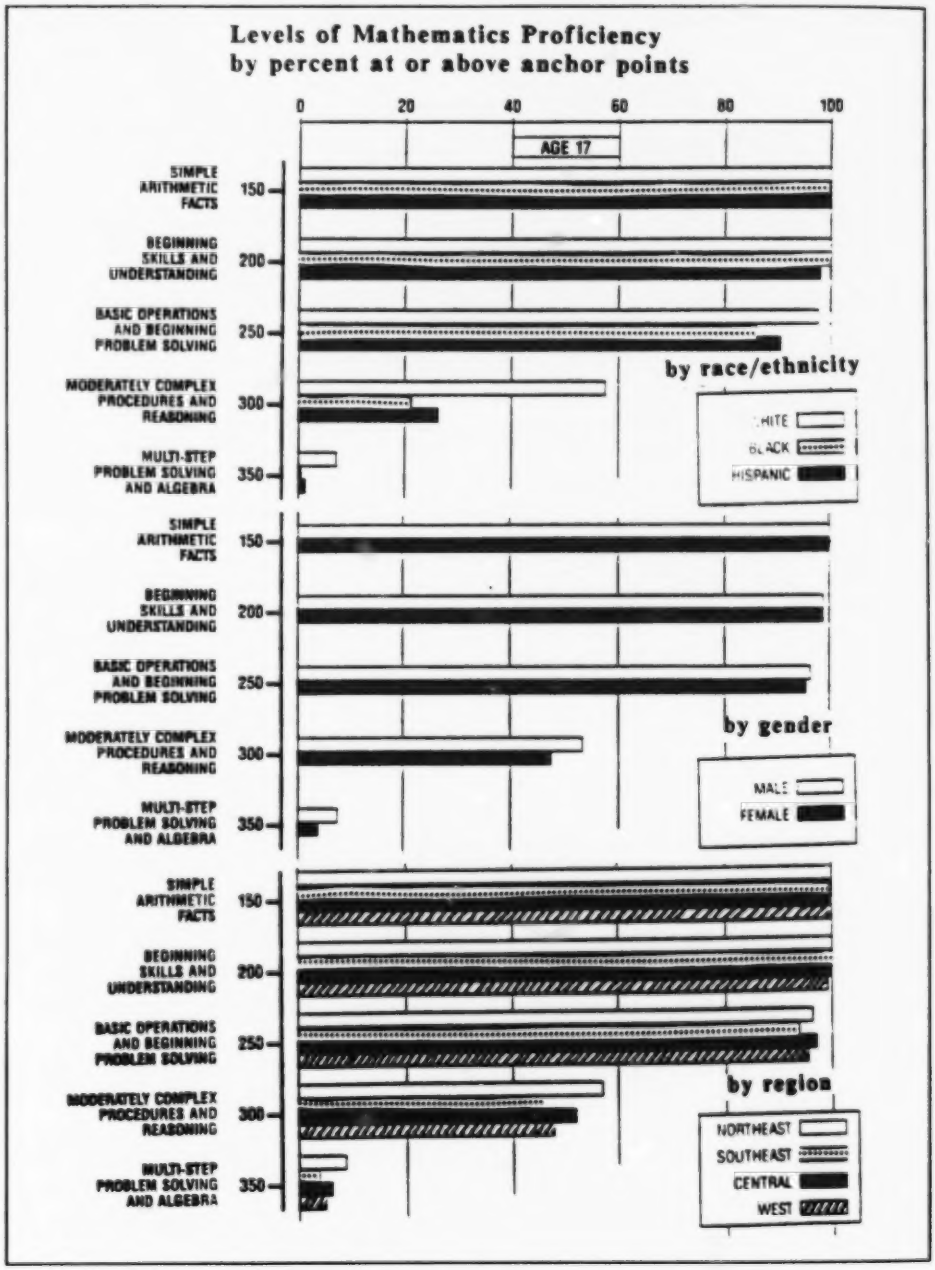
Unlike verbal literacy, the business and higher education communities are faced with re-educating workers and students almost from ground zero on math skills. Not only have workers not used higher order math skills, they probably never learned them. While verbal literacy is tied to a host of social issues, including poverty, the problem of math literacy begins with inadequate instruction. Undoubtedly, some of the same conditions that create verbal illiteracy hamper math literacy as well, but it is math instruction which is under a barrage of criticism and for which a number of reforms are underway.

Math Performance of Students

The Mathematics Report Card, issued by the National Assessment of Educational Progress last June, says that students generally master arithmetic skills before graduating from high school. On this score, younger students (9- and 13-year-olds) have improved in performance, although almost all of that improvement was among black and Hispanic groups. In recent years older students (17-year-olds) have abated a decline which began in 1973.

The unfortunate news from the study, which includes data from the latest assessment in 1986, is that about one-half of the students about to graduate from high school do not have the math skills commonly taught in junior high school. Further, there have been no gains in the past eight years, at least, in the higher-level problem solving skills and in algebra among 17-year-olds.

The study also found that classroom instruction continues to be dominated by teacher explanations, work at the blackboard and textbooks/workbooks. Small group activities, hands-on applications of theory or special projects were rare. Even though 97 percent of the 11th graders' families owned calculators, only about one-fourth of the schools they attended supplied calculators for math use.



from The Mathematics Report Card: Trends and Achievement Based on the 1986 National Assessment, National Assessment of Educational Progress

. . . Poor Global Competitors

While comparisons of educational systems must take characteristics of student populations and other factors into consideration, the bottom line for leaders in this country is performance. On that score, students in the United States are at or near the bottom of the class. For example, a University of Michigan study of elementary students in the United States, Taiwan, Japan and China found our students scoring last in counting, computing, geometry and problem solving. Chinese students did the best. *The Mathematics Report Card* notes that international studies show the average Japanese student has higher levels of math achievement than the top 5 percent of American students enrolled in college preparatory math.

Computer use in math classes has leveled off (at about 57 percent for 11th graders), and the patterns indicate males and high-achieving students are the only groups whose use of computers is increasing.

What Changes Are Needed

It is obvious that not enough students are enrolling in advanced math. The Second International Mathematics Study found that schools in this country begin tracking students in math at the eighth grade (other countries with high performance, such as Japan, do not differentiate the curriculum). The NAEP study confirms this. It says 15 percent of seventh graders in the United States have access to pre-algebra or algebra; 77 percent are in a regular math class, and 6 percent in "other," or remedial. In 1986 a majority of 17-year-olds had not taken any advanced math course; only 40 percent had taken algebra II.

Of the top 10 percent of math performers on the SAT, fewer are selecting careers in math, science and engineering. While they are more likely to choose these areas, the proportion has been declining since 1982. In 1986, only 34 percent of the high-scoring females selected a major in math, science, or engineering, compared to 55 percent of the males. Overall, less than one-half (43.9 percent) of those scoring in the top 10 percent on the math part of the SAT selected careers where their math skills would be heavily used.

For students in the vocational track and planning to enter the labor force immediately after school, the statistics are even bleaker. As employers increase their demands for math skills, the public schools are graduating young people with little knowledge of advanced math. A 1984 analysis of the graduates of 1982 found only 13.2 percent of vocational students had received algebra II credit, only 24.3 percent credit in geometry; and only 1.5 percent, in trigonometry.

Another problem, as noted above, is the level of performance. According to one analysis, 80 percent of math instruction in college is in subjects regularly taught in high school. More than 50 percent is remedial math. NAEP says American businesses spend $25 billion annually to update both math and verbal skills of workers.

Most of those analyzing the math literacy problem agree that a major revolution in how math is taught is in order. The problem is much more complex than persuading teachers (and parents) to allow the use of calculators, or of integrating computer technology.

Math should be viewed as "a way of thinking" that is in continual flux, says Arthur Powell, math professor from Rutgers University. However, he explains, most teachers view it as a static subject, a set of rules that divides answers strictly into right and wrong. But real mathematics should challenge students to predict outcomes, look at alternatives and propose theories--all of which require discussion and involve ambiguities.

At a meeting of teachers involved in the Ford Foundation Urban Mathematics Collaboratives last spring, the participants

recognized that all students must be prepared for a society increasingly influenced by technology and quantitative methods. The teachers listed three major changes needed in math instruction:

o Computers and calculators must be available to all students and used to their full potential in math instruction

o Problems and projects assigned to students must reflect real-world applications of mathematics and theory

o Topics such as probability, statistics and discrete math must become fully integrated into the math curriculum for all students.

Another major area of concern is the supply of math teachers. A Rand Corp. analysis of data from the National Science Foundation concludes that for every newly trained mathematics and science teacher who entered the profession in 1982-83, 12 teachers left. Further, as many as 30 percent of teachers in this field are not fully qualified for the subjects they are teaching; more than 40 percent of the total will retire during the next decade.

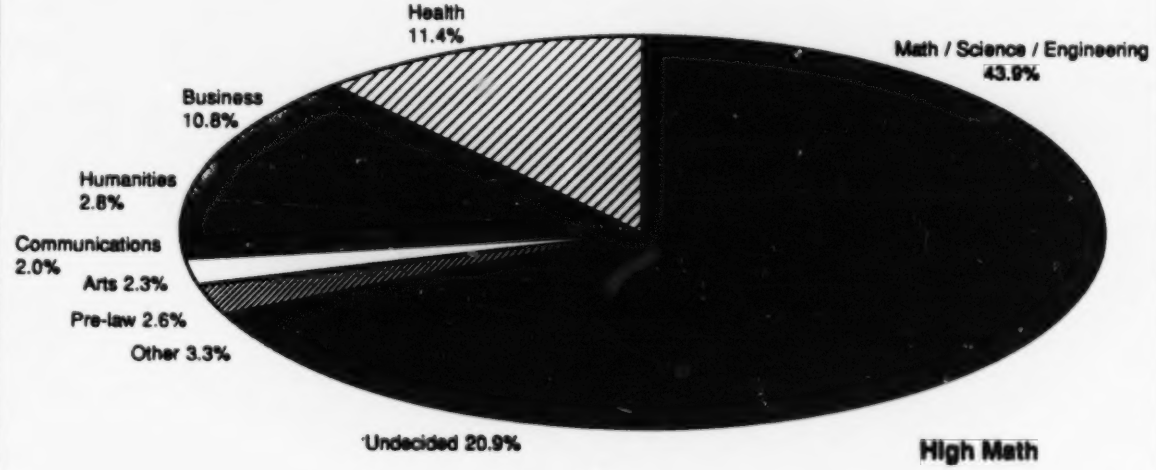
Changes Underway

During the next few months, expect the next round of reports on education to be well-sprinkled with calls for reform in math education.

According to Mark Driscoll of the Education Development Center at Newton, Mass., which works with the Urban Mathematics Collaboratives, the involvement of math teachers will be essential for reforms--and a number of activities are underway to improve their professionalism in math. Other efforts to look for:

o Changes in textbooks that will integrate the various fields in math (the United States is one of the last countries in the world to teach the subjects separately, he says).

Major Field Selections of 1986 High School Seniors Scoring Above the 90th Percentile on SAT Math



from *ETS Policy Notes*, July 1988

o Changes in ways of evaluating students. The computation sections of current standardized tests are under fire.

o Community involvement in pushing for changes, particularly the business sector.

o A movement towards equity. In the past, higher expectations in math performance led teachers of the disadvantaged to comment that this could not be done "with our kids." That attitude is changing, says Driscoll.

Through the Urban Mathematics Collaboratives, teachers are discussing these issues, sharing solutions and working toward teaching different mathematical ideas.

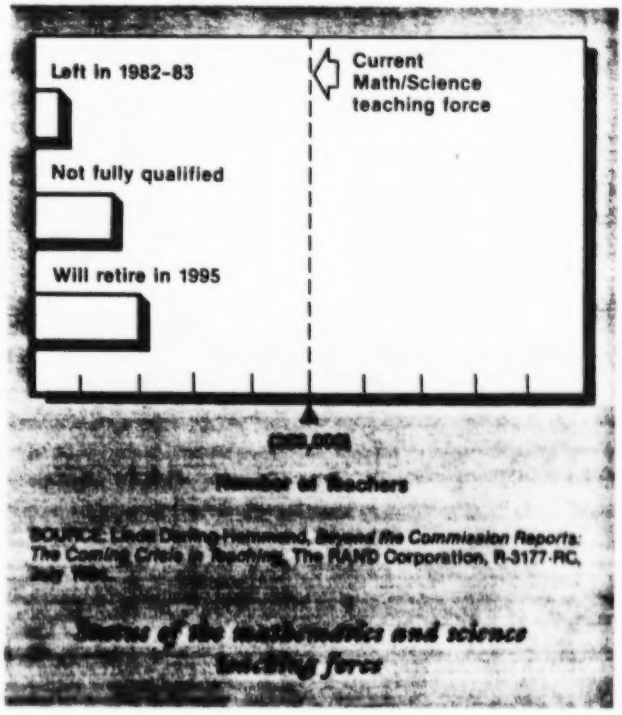
As a corollary, the National Council of Teachers of Mathematics will issue ground-breaking standards for school mathematics next March after a two-year study by a special Commission. For the K-12 curriculum, the standards are a response "to the current crisis in the teaching and learning of mathematics," according to NCTM. The standards will give greater emphasis to conceptual development, mathematical reasoning and problem solving.

The Mathematical Sciences Education Board of the National Research Council was formed three years ago by leaders from the math and science/engineering communities who were concerned about the status of math education. Its report on the status of math education and math skills needed for the next century will be issued in a few months. According to Marcia Sward, executive director, the report will be followed by a Board-sponsored "Year of Dialogue" on math needs involving educators and community groups throughout the country.

The Board also will bring together math educators, leading businesspeople and others for a conference on "Mathematics Education: Wellspring of U.S. Industrial Strength" at the Beckman Center in Irvine, Calif., Dec. 15-16.

A six-year project to reform math education is underway at the University of Chicago, sponsored by several foundations and the National Science Foundation. Also a K-12 effort, the University of Chicago School Mathematics Project is preparing materials for different levels and training teachers. Its curriculum integrates technology in the early years and draws upon materials used in other countries.

With $171 million to invest in improving science and math education, the National Science Foundation is working on almost all of the issues above, according to David Florio, program director of the Office of Studies and Program Assessment. These include improved content, teacher recruitment and training and educating the public to view math education "as more than just arithmetic."


Left in 1982-83
Current Math/Science teaching force
Not fully qualified
Will retire in 1995
Number of Teachers
SOURCE: Linda Darling-Hammond, Beyond the Commission Reports: The Coming Crisis in Teaching, The RAND Corporation, R-3177-RC, July 1990.
Sources of the mathematics and science teaching force

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